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SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

ISDN user-network interfaces

Overview of Recommendations on Layer 1 for ISDN and B-ISDN customer accesses

ITU-T Recommendation I.414

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION I.414

OVERVIEW OF RECOMMENDATIONS ON LAYER 1
FOR ISDN AND B-ISDN CUSTOMER ACCESSES

Summary

This Recommendation describes the configurations of ISDN and B-ISDN customer accesses, and lists the relevant reference points for the access network interfaces. This Recommendation gives an overview of the relevants Recommendations mainly on Layer 1 aspect for ISDN and B-ISDN customer accesses.

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CONTENTS

Recommendation I.414

OVERVIEW OF RECOMMENDATIONS ON LAYER 1
FOR ISDN AND B-ISDN CUSTOMER ACCESSES

(Geneva, 1997)

1   Scope

This Recommendation describes the configurations of ISDN and B-ISDN customer accesses, and lists the relevant reference points for the access network interfaces. This Recommendation gives an overview of the relevant Recommendations mainly on Layer 1 aspect for ISDN and B-ISDN customer accesses.

2   References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T Recommendation G.701 (1993), *Vocabulary of digital transmission and multiplexing, and Pulse Code Modulation (PCM) terms*.

– ITU-T Recommendation G.704 (1995), *Synchronous frame structures used at 1544, 6312, 2048, 8488 and 44 736 kbit/s hierarchical levels*.

– ITU-T Recommendation G.707 (1996), *Network node interface for the Synchronous Digital Hierarchy (SDH)*.

– ITU-T Recommendation G.784 (1994), *Synchronous Digital Hierarchy (SDH) management*.

– ITU-T Recommendation G.804 (1993), *ATM cell mapping into Plesiochronous Digital Hierarchy (PDH)*.

– ITU-T Recommendation G.902 (1995), *Framework Recommendation on functional access networks – Architecture, and functions, access types management and service node aspects*.

– ITU-T Recommendation G.960 (1993), *Access digital section for ISDN basic rate access*.

– ITU-T Recommendation G.961 (1993), *Digital transmission system on metallic local lines for ISDN basic rate access*.

– ITU-T Recommendation G.962 (1993), *Access digital section for ISDN primary rate at 2048 kbit/s*.

– ITU-T Recommendation G.963 (1993), *Access digital section for ISDN primary rate at 1544 kbit/s*.

– ITU-T Recommendation G.964 (1994), *V-interfaces at the digital Local Exchange (LE) – V5.1-interface (based on 2048 kbit/s) for the support of Access Network (AN)*.

– ITU-T Recommendation G.965 (1995), *V-interfaces at the digital Local Exchange (LE) – V5.2-interface (based on 2048 kbit/s) for the support of Access Network (AN)*.

– ITU-T Recommendation I.112 (1993), *Vocabulary of terms for ISDNs*.

– ITU-T Recommendation I.113 (1997), *Vocabulary of terms for broadband aspects of ISDN*.

– ITU-T Recommendation I.411 (1993), *ISDN user-network interfaces – Reference configurations*.

– ITU-T Recommendation I.413 (1993), *B-ISDN user-network interface*.

– ITU-T Recommendation I.430 (1995), *Basic user-network interface – Layer 1 specification*.

– ITU-T Recommendation I.431 (1993), *Primary rate user-network interface – Layer 1 specification*.

–   ITU-T Recommendation I.432.1 (1996), *B-ISDN user-network interface – Physical layer specifiction: general characteristics*.

–   ITU-T Recommendation I.432.2 (1996), *B-ISDN user-network interface – Physical layer specification: 155 520 kbit/s and 622 080 kbit/s operation*.

–   ITU-T Recommendation I.432.3 (1996), *B-ISDN user-network interface – Physical layer specification: 1544 kbit/s and 2048 kbit/s operation*.

–   ITU-T Recommendation I.432.4 (1996), *B-ISDN user-network interface – Physical layer specification: 51 840 kbit/s operation*.

–   ITU-T Recommendation I.432.5 (1997), *B-ISDN user-network interface – Physical layer specification: 25 600 kbit/s operation*.

–   CCITT Recommendation I.601 (1988), *General maintenance principles of ISDN subscriber access and subscriber installation*.

–   ITU-T Recommendation I.610 (1995), *B-ISDN operation and maintenance principles and functions*.

–   ITU-T Recommendation I.731 (1996), *Types and general characteristics of ATM equipment*.

–   ITU-T Recommendation I.732 (1996), *Functional characteristics of ATM equipment*.

–   CCITT Recommendation M.3602 (1992), *Application of maintenance principles to ISDN subscriber installations*.

–   CCITT Recommendation M.3603 (1992), *Application of maintenance principles to ISDN basic rate access*.

–   CCITT Recommendation M.3604 (1992), *Application of maintenance principles to ISDN primary rate access*.

   NOTE – Recommendations M.3602 to M.3604 were formerly numbered as Recommendations I.602 to I.604, respectively.

–   ITU-T Recommendation Q.512 (1995), *Digital exchange interfaces for subscriber access.*

3   Abbreviations and definitions

3.1   Abbreviations

This Recommendation uses the following abbreviations:

ATM   Asynchronous Transfer Mode

ET   Exchange Termination

NT   Network Termination

PDH   Plesiochronous Digital Hierarchy

PMD   Physical Media Dependent

SNI   Service Node Interface

SDH   Synchronous Digital Hierarchy

TE   Terminal Equipment

TC   Transmission Convergence

UNI   User Network Interface

VC   Virtual Channel

VCC   Virtual Channel Connection

VP   Virtual Path

3.2   Definitions

Definitions of terms and abbreviations for ISDN customer access used in this Recommendation and the listed Recommendations are defined in the Recommendations I.112 and G.701.

Definitions of terms and abbreviations for B-ISDN customer access used in this Recommendation and the listed Recommendations are defined in Recommendation I.113.

3.2.1   B-ISDN Layer 1: The functions of the Physical Layers of the B-ISDN Protocol Reference Model as defined in Recommendation I.321, which includes the PMD (Physical Media Dependent) and TC (Transmission Convergence) sublayers only.

4   ISDN customer access

Figure 1 shows an overview of access arrangements and gives the relevant Recommendations on layer 1 for ISDN customer access. Relevant Recommendations are given in Tables 1-1 and 1-2. Requirements for V-reference points are defined in Recommendation Q.512.

The access arrangements shown in Figure 1 are not intended to be either exhaustive or mandatory. Other Recommendations also affecting Layer 1 aspects (e.g. protection against overvoltages, electric safety requirements, etc.) are referred to in some Layer 1 Recommendations at the appropriate place.

5   B-ISDN customer access

Figure 2 shows an overview of access arrangements and gives the relevant Recommendations mainly for B-ISDN customer access. Relevant Recommendations and their status are given in Tables 2-1 and 2-2.

The access arrangements shown in Figure 2 are not intended to be either exhaustive or mandatory. Other Recommendations also affecting Layer 1 aspects are referred to at the appropriate clauses of these Recommendations.

The following types of broadband access arrangements have been identified:

a)   *Direct access arrangements*

In a direct access arrangement the UNI is connected to the ET function in the SN through its individual broadband access digital section which is using a transmission system. There is functionally an individual V_B1 reference point between the ET function and the broadband access digital section for any individual customer.

Two applications are contained in the direct access arrangement:

1)   the homogeneous case where the transport capacity at the UNI is identical to the transmission system used in the broadband access digital section;

2)   the non-homogeneous case where a transmission system with lower transport capacity is used other than at the UNI.

The additional requirements for case 2) are defined in an annex to Recommendation G.96x.

This case is illustrated at the top part of Figure 2.

b)   *Remote access arrangements with ATM multiplexing/cross connecting in the access network*

In this remote access arrangement, the UNI is connected to the ET function in the SN through an access network which performs multiplexing/cross connecting functions at the VP and/or VC layer under control of the access network management. The access network may include broadband access digital sections, further digital sections, and multiplexing/cross connecting functions at the transmission layer (e.g. SDH).

This case is illustrated as the second type in Figure 2.

c)   *Remote access arrangements with additional on-demand allocation of VCCs in the access network*

As for the remote access arrangement described in case b), the UNI is connected to the ET function in the SN through an access network. In addition to the functions described for case b), this type of broadband access arrangement includes on-demand VC connection allocation functions in the access network under control of the service node.

This case is illustrated at the bottom part of Figure 2.

Other remote access arrangements and relevant V_B reference points may be defined later if required for specific broadband network design and interface specifications.
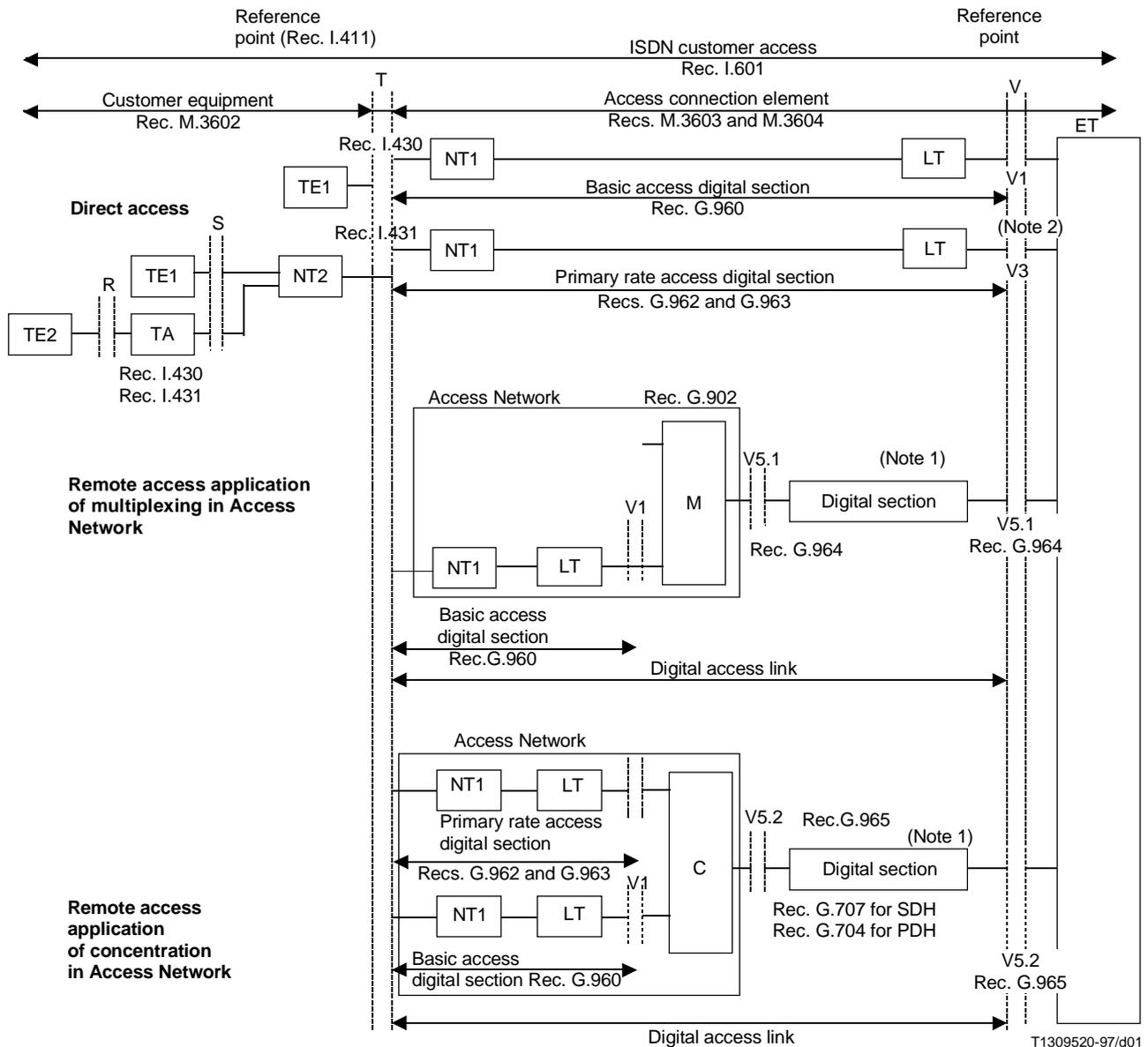
Figure 1/I.414 – Overview of Recommendations on Layer 1 for ISDN customer access

**Table 1-1/I.414 – Recommendations related to Layer 1 of ISDN UNI
and direct customer access**

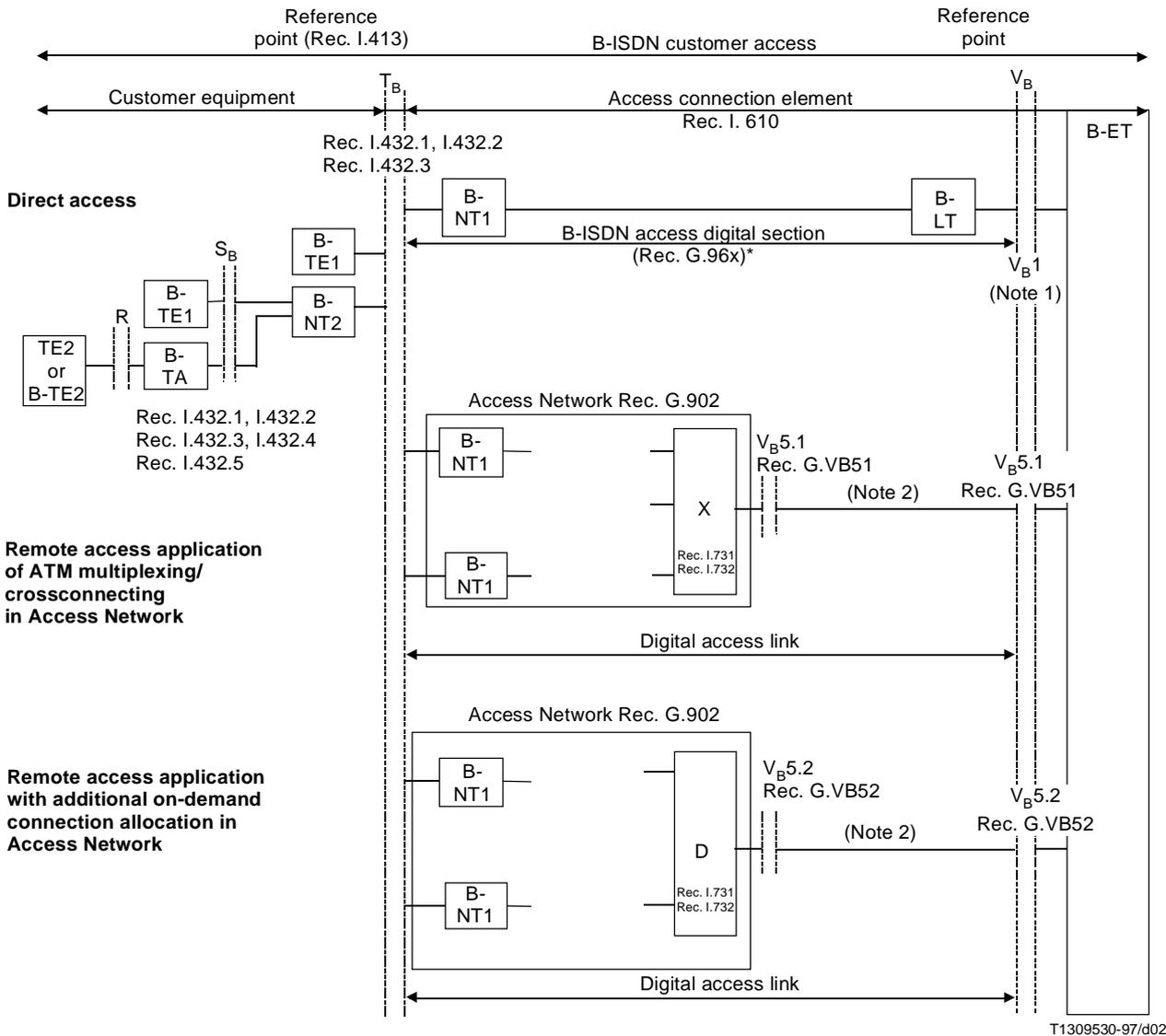| Access type	User network interface		Access digital section (media independent)	Digital transmission system (media dependent)		Maintenance principles
	Medium	**Recommendation**		**Medium**	**Recommendation**	
Basic rate access	Metallic pair	I.430	G.960	Metallic pair	G.961	M.3603
Primary rate access	Metallic pair	I.431	G.962 G.963	(Note)		M.3604
NOTE – Not yet defined.						

**Table 1-2/I.414 – Recommendations related to access networks
(remote customer access)**

Access types	V reference point	SNI Recommendation	Bearer handling	Architecture Recommendation
Basic rate access	V5.1	G.964 (Note 1)	Multiplexing	G.902
	V5.2	G.965 (Note 1)	Concentration	
Primary rate access	V3	G.962 (Note 1) G.963 (Note 2)	Transparent transport	
	V5.2	G.965 (Note 1)	Concentration	
Recommendations G.964 and G.965 support PSTN access types as well. NOTE 1 – Using 2 Mbit/s interfaces. NOTE 2 – Using 1.5 Mbit/s interfaces.				

Figure 2/I.414 – Overview of Recommendations for B-ISDN customer access

Reference point (Rec. I.413) — B-ISDN customer access — Reference point

Customer equipment — Access connection element Rec. I. 610

T_B

V_B

B-ET

Rec. I.432.1, I.432.2
Rec. I.432.3

Direct access

S_B

B-NT1 — B-ISDN access digital section (Rec. G.96x)* — B-LT

V_B1
(Note 1)

B-TE1

B-TE1

B-NT2

TE2 or B-TE2 — R — B-TA

Rec. I.432.1, I.432.2
Rec. I.432.3, I.432.4
Rec. I.432.5

Access Network Rec. G.902

B-NT1

B-NT1

X

Rec. I.731
Rec. I.732

$V_B5.1$
Rec. G.VB51
(Note 2)

$V_B5.1$
Rec. G.VB51

Remote access application of ATM multiplexing/ crossconnecting in Access Network

Digital access link

Access Network Rec. G.902

B-NT1

B-NT1

D

Rec. I.731
Rec. I.732

$V_B5.2$
Rec. G.VB52
(Note 2)

$V_B5.2$
Rec. G.VB52

Remote access application with additional on-demand connection allocation in Access Network

Digital access link

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Reference point

X   VP/VC multiplexing/crossconnecting under the access network management (e.g. provisioning).
D   on-demand connection allocation with broadband bearer connection control from Service Node (for further study).
G.VB51 and G.VB52 interface specifications are not available yet.
*   Under study.

NOTE 1 – Interface specification at this reference point is not considered for standardization.

NOTE 2 – The application of the digital section between Access Network and Service Node require further study (e.g. Recommendation G.707 for SDH and Recommendation G.804 for PDH)

Figure 2/I.414 – Overview of Recommendations for B-ISDN customer access

**Table 2-1/I.414 – Recommendations related to Layer 1 of B-ISDN UNI
and direct customer access**

User network interface			Access digital section (media independent)	Digital transmission system (media dependent)	Maintenance principles
Medium	Recommendation		Recommendation	Medium	Recommendation
	T_B	S_B			
Twisted pair cable	I.432.3	I.432.3 I.432.4 I.432.5	(G.96x) (Note)	None	I.610 (ATM) G.784 (SDH)
Coaxial cable	I.432.2 I.432.3	I.432.2 I.432.3			
Optical fibre	I.432.2	I.432.2			
NOTE – Under study.					

Table 2-2/I.414 – Recommendations related to B-ISDN access networks

Access configuration	V reference point	SNI Recommendation	Bearer handling	Architecture Recommendation
Direct access	V_B1	(Note 2)	B-ISDN access digital section G.96x (Note 1)	G.902
Remote access	$V_B5.1$ (Note 3)	G.VB51 (Note 1)	Remote access with VP and/or VC multiplexing/ crossconnecting under the access network management (Note 1)	
	$V_B5.2$ (Note 3)	G.VB52 (Note 1)	Remote access with additional on-demand connection allocation of VCCs under Service Node control (Note 1)	
NOTE 1 – Under study.				
NOTE 2 – Interface specification at this reference point is not considered at present.				
NOTE 3 – PSTN and narrow-band ISDN access may be supported through this interface by use of direct ATM circuit emulation or by V5.1 and/or V5.2 interface with ATM circuit emulation in the access network.				

Appendix I

Examples of access network implementation and the related basic requirements on V_B interfaces

I.1   Introduction

This Appendix provides examples of access network implementation and the related basic requirements on V_B interfaces. The examples are not intended to be either exhaustive or mandatory. Under the open networking concept, a study of standard Service Node Interface, SNI (V_B5), specifications is one of the important issues to allow us to have flexible and service integrated B-ISDN access networks.

I.2 Examples of access network implementation and the related basic requirements

I.2.1 Access network architecture

Figure I.1 shows the role of the access network in the overall network architecture. ATM-PON (Passive Optical Network) is shown as an example of the optical access systems. The access network assures a link between a final user and one of four main kinds of service nodes for such as PSTN/ISDN services, B-ISDN services, and non-ATM based networks (e.g. for digital video delivery service and IP-based Internet-like service). The four types of network services are logically separated, but can be supported by the same transport layer in the access network. A minimum set of standard SNIs should be specified between the service integrated access network and each service node.
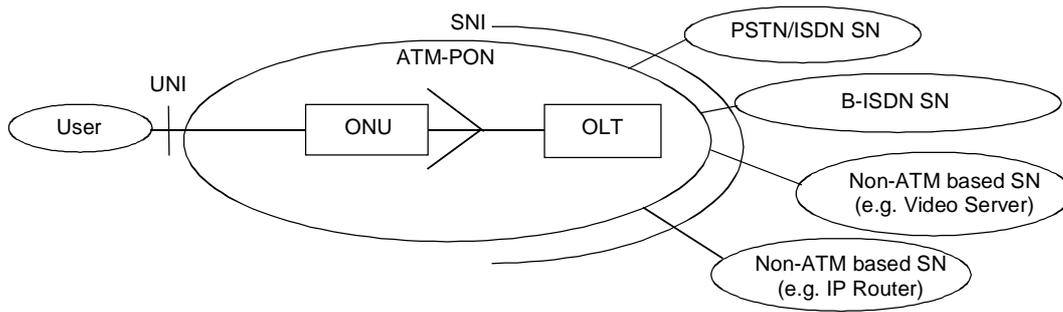
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Figure I.1/I.414 – Basic network model

Figure I.2 shows an access network system architecture based on Recommendation G.902 that is capable of supporting various services such as PSTN, ISDN, VOD (Video-On-Demand) and ATM (PVC, SVC). The access network function consists of four functions, the transport function, the core function, the user port function and the service port function.

1) *Transport function*

   – Line transmission

   – Multiplexing

   – Crossconnect

2) *User port function*

   – UNI line termination

   – A/D conversion

   – Network termination

3) *Service port function*

   – SNI line termination

4) *Core function*

   – Concentration

   – Circuit emulation

   – Channel selection

The transport function is independent of services, and the three others are dependent of services. These functions are equipped in ONU (Optical Network Unit) and OLT (Optical Line Termination) as illustrated in Figure I.2.
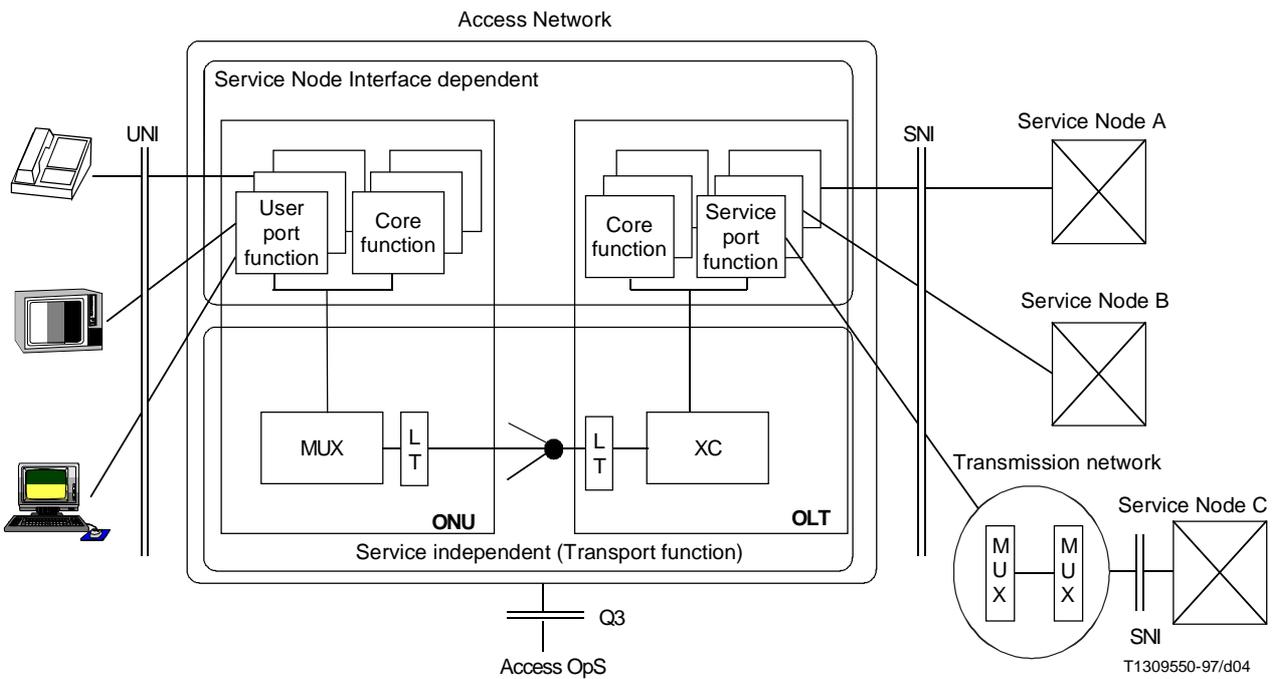
Figure I.2/I.414 – Access network system architecture based on Recommendation G.902

I.2.2 Service specific functions

Figure I.3 shows the layered structure of an access network based on Recommendation G.902. This can be elaborated according to the services actually provided. Figures I.4, I.5, I.6, I.7 and I.8 show examples of protocol stacks and functional blocks for an access system, each corresponding to a different service such as IP routing, SVC, VOD, switched video and PSTN/ISDN. To identify the interface requirements for the UNI and the SNI, the required signalling or control channels should be clarified.
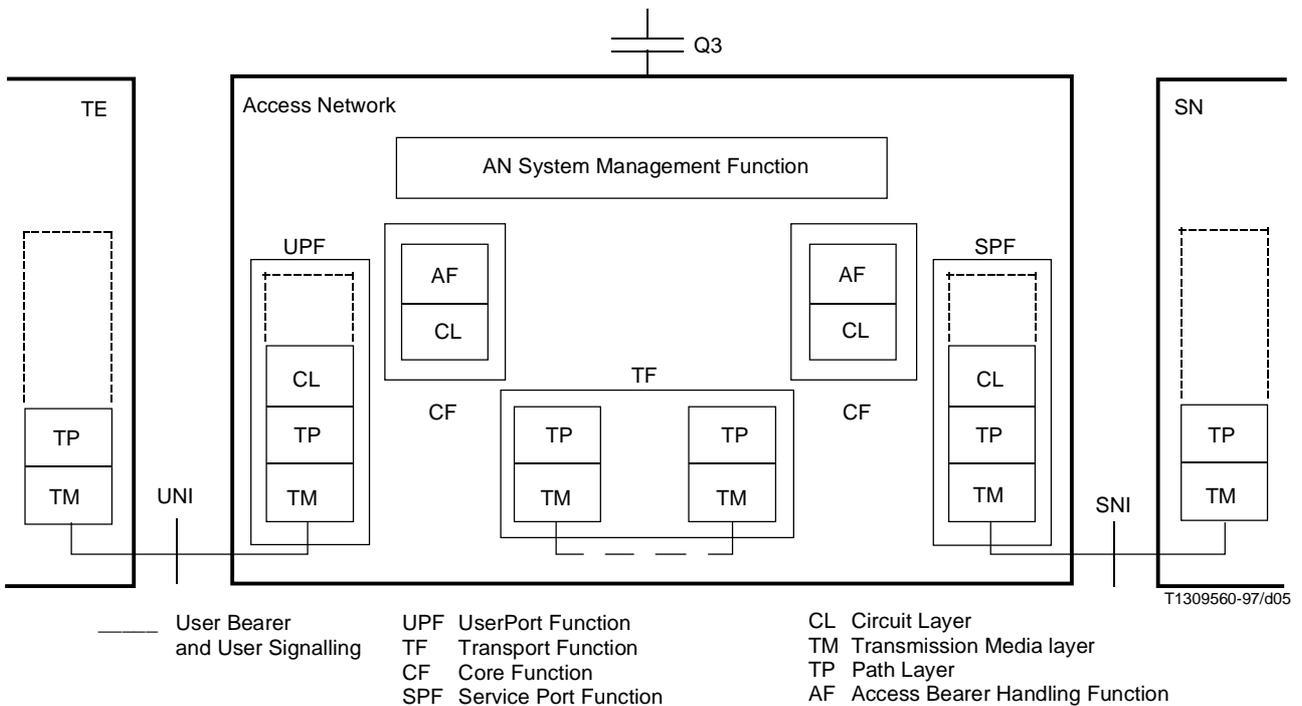

Figure I.3/I.414 – Layered structure of an access network based on Recommendation G.902

A case of IP routing service is shown in Figure I.4. Two types of ONU are depicted to support Internet service access to carry IP data over ATM. One has IP filtering function to provide the IP access over the Ethernet interface directly. The other ONU directly accommodates the ATM interface defined by I.432-Series Recommendations. The ATM signalling among IP router, OLT, ONU and TE will not be needed to provide the IP access to the IP router, if permanent ATM VP/VC connections carry IP signals. Necessary control will be made in a higher layer. As an example of the economical Internet access provision, EPD (Early Packet Discarding)-based multiplexing can be adopted to increase multiplexing efficiency to the IP router (Service node). The EPD can be implemented at the ATM layer in the access node independent of the service node management, which discards all ATM cells in the IP packet when an ATM cell in one IP packet is lost. An ATM-based SNI like $V_B5.1$ should be specified.
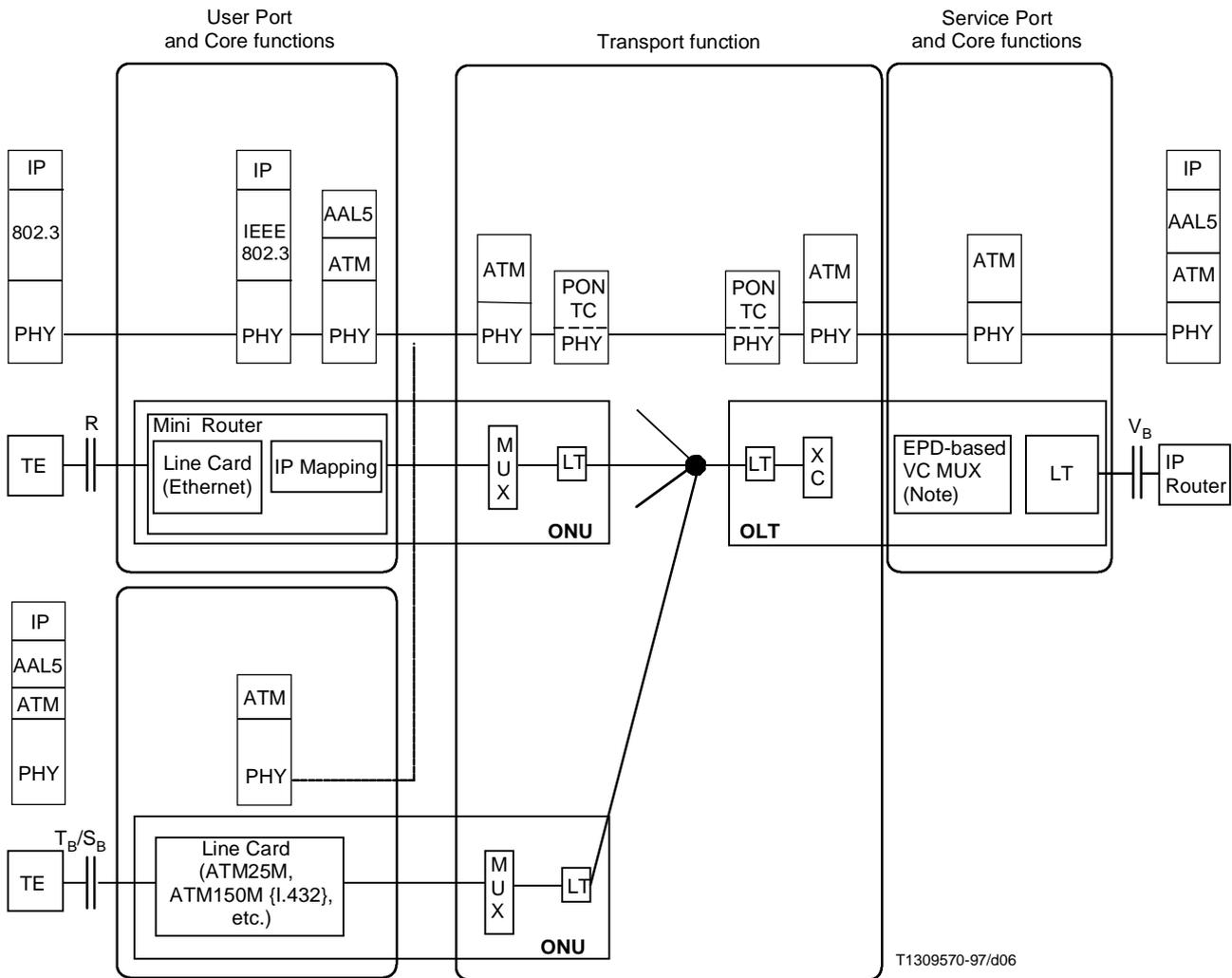
NOTE – An example of a buffering implementation.

**Figure I.4/I.414 – Example for functional architecture of protocol stack
and functional block diagram (IP Routing)**

A case of ATM-SVC service is shown in Figure I.5. The VC concentration function that improves V_B interface efficiency is controlled through BCC (Bearer Control Channel) in the V_B interface by the ATM switch on-demand basis. The Q.2931 protocol, which is used as signalling between a terminal and the ATM switch, is not terminated in access networks. The VC concentration function is usually associated with the UPC function to regulate the activated VC traffic. An ATM-based SNI like $V_B5.2$ with remote concentration in the access network will be used.
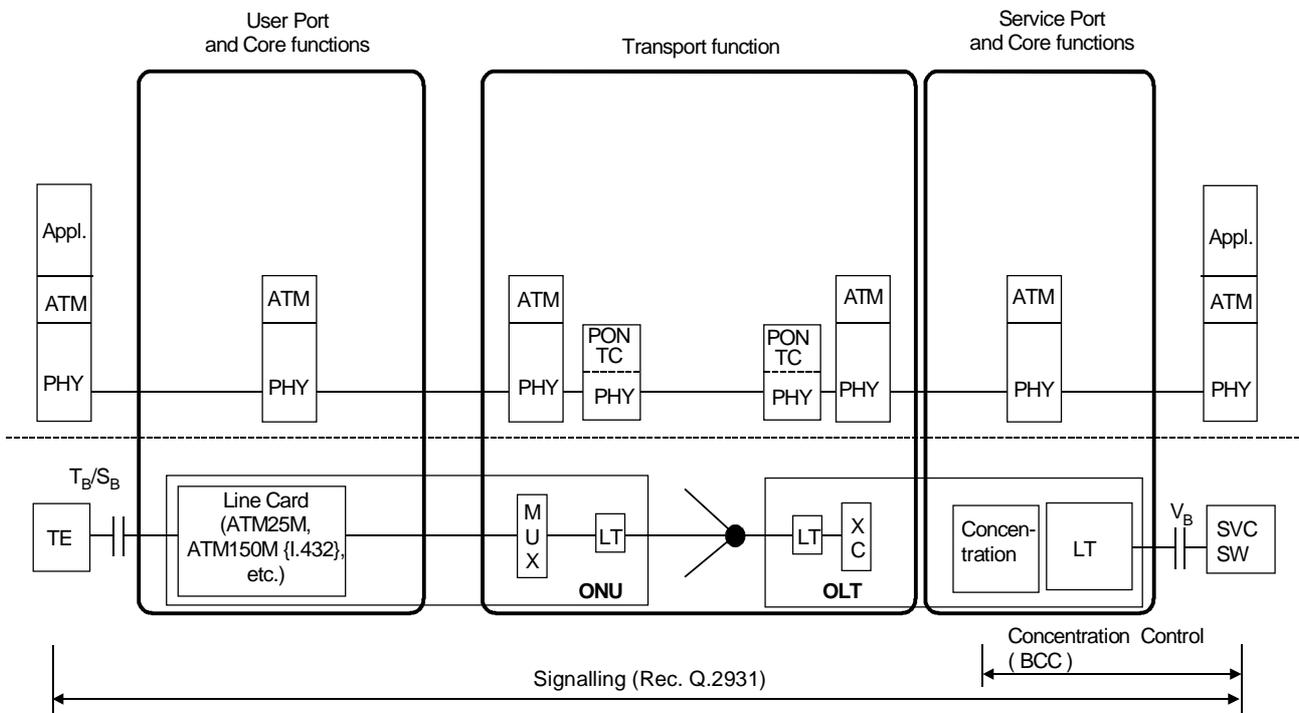

Figure I.5/I.414 – Example for functional architecture of protocol stack and functional block diagram (SVC)

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A case of VOD service case is shown in Figure I.6. No specific function dedicated to this service is required in access networks. To manage digital video resources in the server, server control signalling (e.g. UDP/IP/AAL5/ATM) will be adopted between a TE (e.g. Set Top Box) and the VOD server (Service node) and is not terminated in access networks. It will be cost-effective to use IP routing network mentioned above for transporting this signal. The ATM connection to carry the signalling channel is semi-permanently provided by provisioning basis. An ATM-based SNI like $V_B5.1$ should be specified.

A case of switched video service is shown in Figure I.7. Digital video channel is selected at the channel selector in OLT using a channel-selecting protocol according to a customer request. The control signal for channel selection is exchanged between STU (Set-Top-Unit) in customer premises and the video channel selector in the OLT. In case of pay per view, the signalling is needed between the STU and the Service Node, that is the headend. In this case, the video channel selector might be controlled by the Service Node to restrict some customers to select specific channels. ATM-based SNIs like $V_B5.1$ should be specified.

A case of PSTN/ISDN service is shown in Figure I.8. CLAD (Cell Assembly and Disassembly) function is required to convert the transfer mode for information between STM and ATM. This function is usually in ONU as well as OLT. There can be a case the concentration function for POTS/ISDN channels is included in the access network, although the figure does not show this case. The existing T and V interfaces are supported transparently over the ATM access networks to the existing service nodes.
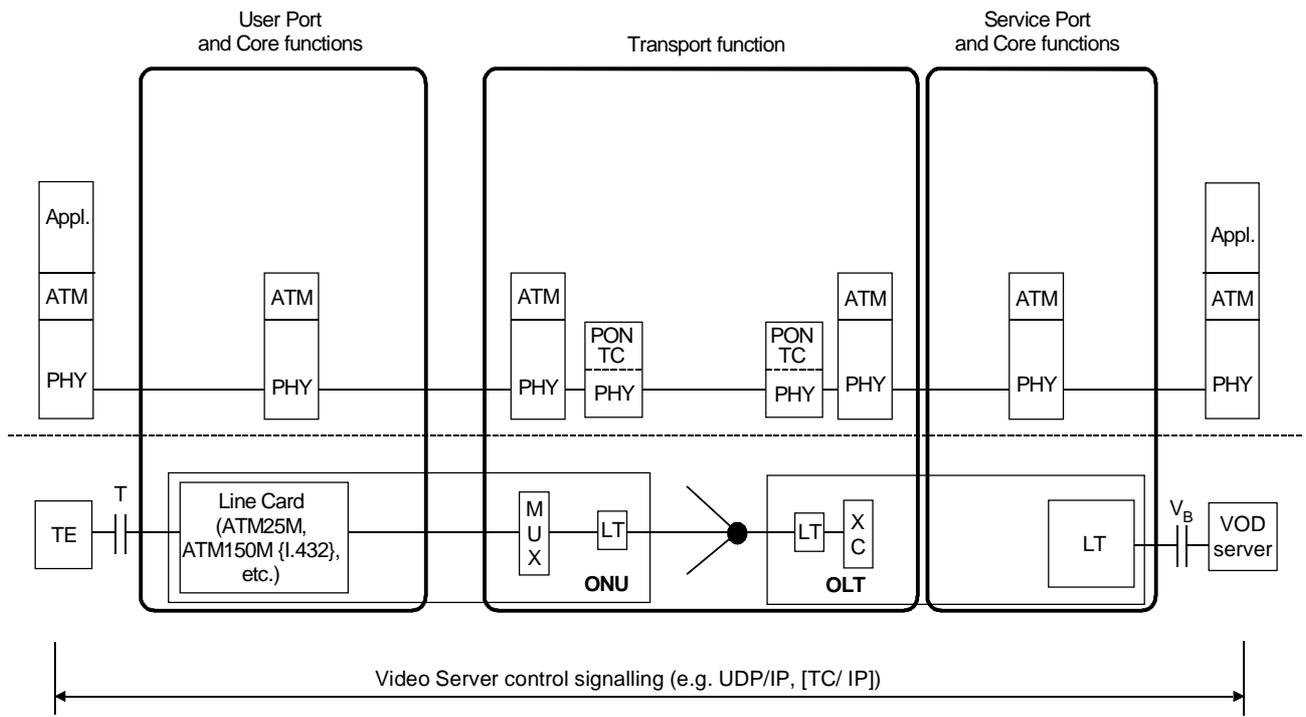
**Figure I.6/I.414 – Example for functional architecture of protocol stack
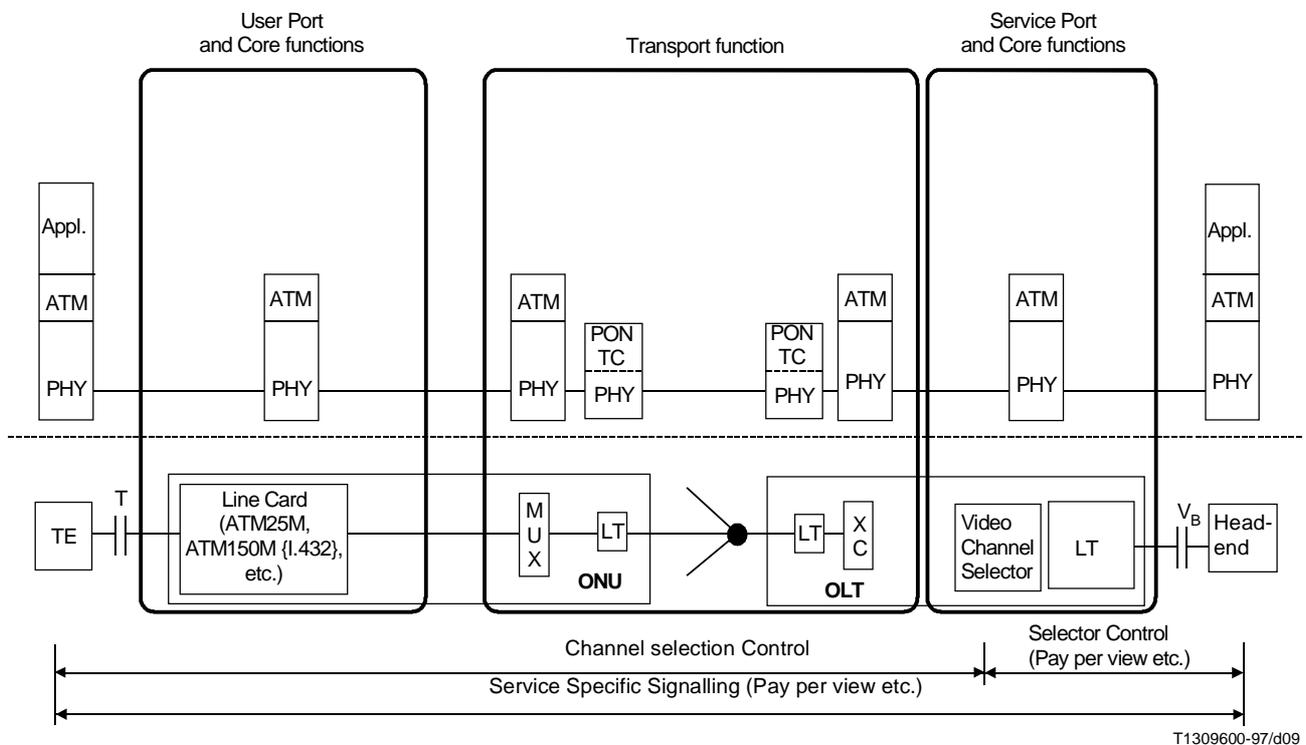and functional block diagram (VOD)**

**Figure I.7/I.414 – Example for functional architecture of protocol stack
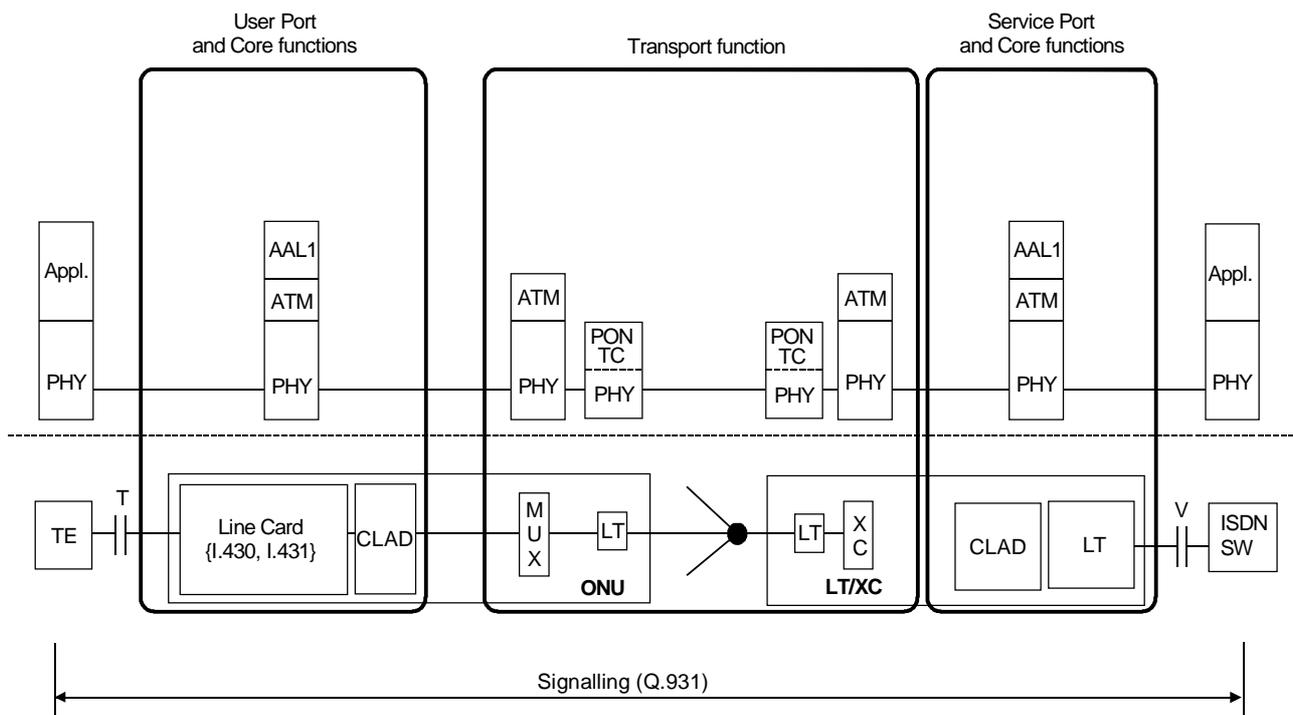functional block diagram (Switched Video Broadcasting)**

Figure I.8/I.414 – Example for functional architecture of protocol stack and functional block diagram (ISDN)

I.2.3 Possible access system architecture example

ONU and OLT will equip various interfaces and functions depending on a providing service. However, a service actually provided will be changed depending on a service introduction planning and a schedule of a carrier. Therefore, user port function, core function and service port function which are dependent of service can be equipped in ONU and OLT as an optional function according to the carrier's request. On the other hand, the transport function which is independent of service will be a common platform of access network.

An example of an access system architecture is shown in Figure I.9.

### I.3 Specific interfaces for UNI and SNI

The following examples of UNIs and SNIs will be required to be equipped with ONU and OLT. It is proposed that two types of V_B interfaces should be defined. One is $V_B5.1$ for the remote access network with VP/VC multiplexing and crossconnection under the access network management. The other is $V_B5.2$ for the remote access network with on-demand connection allocation control via $V_B5.2$ under the service node management. See Table I.1.

I.4 Performance parameters

Performance parameters for an ATM-based access network will be bandwidth, access transmission delay, access delay, response time and cell discard ratio. A specification of this performance is varied depending on services. The specific parameters require further study.

Table I.1/I.414 – Examples of specific interfaces for UNI and SNI

Service	UNI	SNI
IP routing	Ethernet (e.g. IEEE802.3), 25 Mbit/s (Rec. I.432.5)	$V_B5.1$
ATM switched VC	25 Mbit/s (Rec. I.432.5), 155 Mbit/s (Rec. I.432.2)	$V_B5.1$, $V_B5.2$
Video-on-Demand	25 Mbit/s (Rec. I.432.5), 155 Mbit/s (Rec. I.432.2)	$V_B5.1$
Switched video broadcasting	25 Mbit/s (Rec. I.432.5), 155 Mbit/s (Rec. I.432.2)	$V_B5.1$
ISDN	64 kbit/s (Rec. I.430), 1.5/2 Mbit/s (Rec. I.431)	V5, etc.
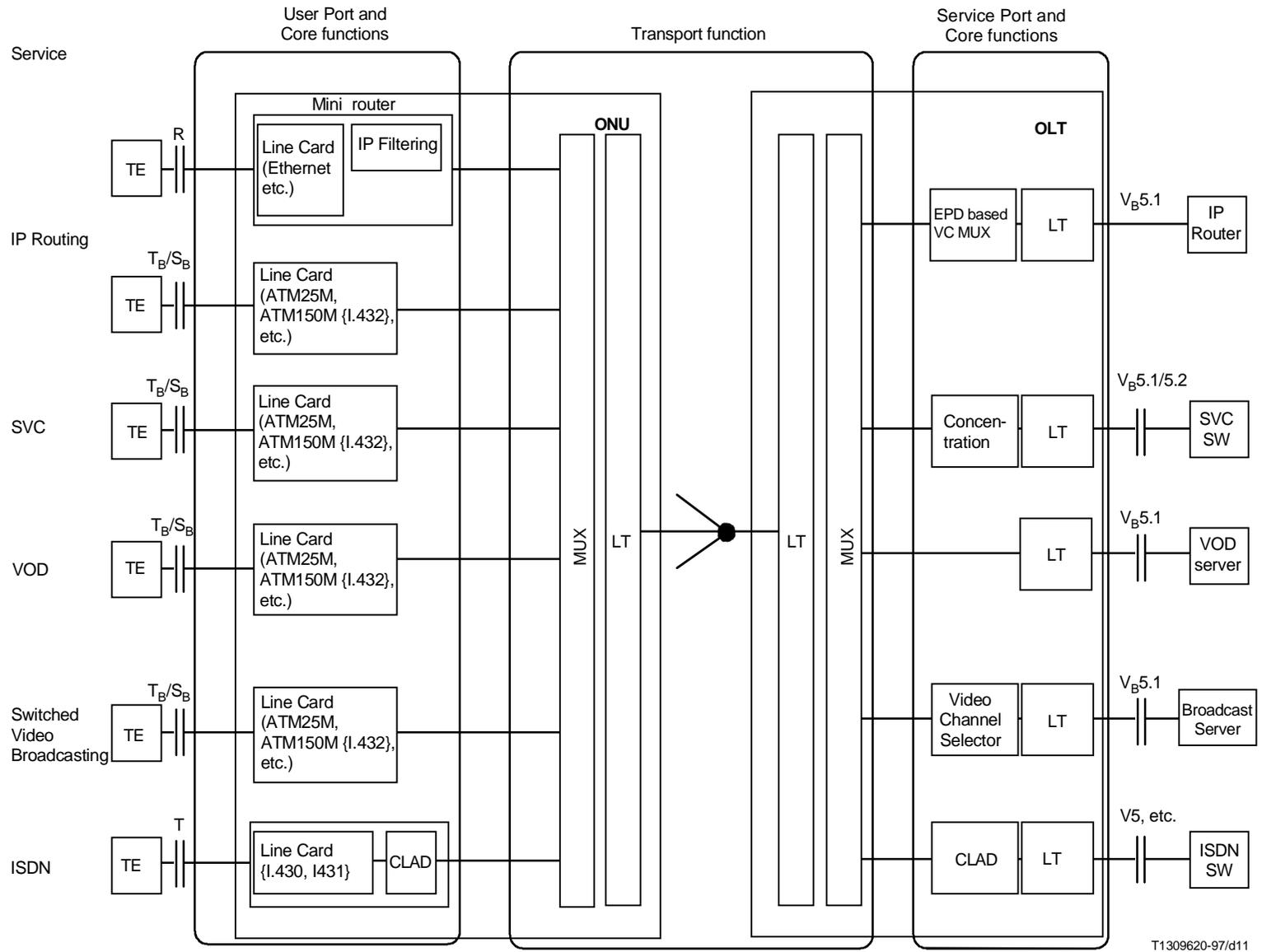
Figure I.9/I.414 – Possible schematic diagram example of an access system

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